ECCR Evaluation and Recommendations

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Submitted by

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The National Center for Defense manufacturing and Machining (NCDMM) was requested by Letterkenny Army Depot (LEAD) to evaluate the ventilation and air filtration needs of the Electronic Component Composite Repair (ECCR) area of Building 350 and recommend equipment that may be purchased to reduce the levels of airborne contaminants. This is an area of high dust generation from sanding and grinding on various sizes of mobile shelters and HMMWV body parts.

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Letterkenny Army Depot Engineering Support

ECCR Evaluation and Recommendations

1.0 EXECUTIVE SUMMARY

The National Center for Defense manufacturing and Machining (NCDMM) was requested by Letterkenny Army Depot (LEAD) to evaluate the ventilation and air filtration needs of the Electronic Component Composite Repair (ECCR) area of Building 350 and recommend equipment that may be purchased to reduce the levels of airborne contaminants. This is an area of high dust generation from sanding and grinding on various sizes of mobile shelters and HMMWV body parts.

The needs of the area were evaluated concurrently with new procedures and vacuum collection sanding and grinding tools being introduced. The scope of this project was limited to evaluation and recommendations for full utilization of existing equipment and specifications for new equipment to clean the residual dust from the ambient air.

This report includes general recommendations for dust collection and air filtration in individual areas of the ECCR when working on specific types of equipment. It also includes equipment purchase descriptions for shelter ventilators and ambient air cleaners to remove residual airborne dust and containments. Additionally, some other potential options are identified for future consideration if reconfiguration or relocating of the ECCR is considered.

2.0 CURRENT ISSUES

The workers in the ECCR area of Building 350 perform sanding and grinding operations, which generate large amounts of dust from body filler compound, paint and metal coatings. In addition to the personnel being exposed to general irritants, previous samples from filters in a dust booth indicated the presence of lead, chromium and cadmium. Subsequent tests monitoring actual personnel verified safe limits of exposure at that time. In a proactive effort to minimize exposure, a dust collection system was installed in a

portion of the ECCR area and vacuum collection tools were purchased and are also being introduced.

However, there is still residual dust from the sanding operations that cannot be captured by the vacuum tool system and on some occasions tools are used which are not compatible with the vacuum system.

There are three separate issues currently faced in the ECCR area:

- Sanding in the existing dust booths.
- Air quality inside the shelters.
- Ambient air quality in the entire ECCR.

2.1 Existing Dust Booths

The existing five dust collection booths at the end of the main ECCR bay are of vintage technology and not powerful enough to pull all of dust into the filters that is currently produced when sanding vehicle parts. In addition, these booths are equipped with low efficiency, single stage filtration that permits only partially cleaned air to return to the ambient.

2.2 Air Quality Inside Shelters

When sanding inside a shelter, the residual dust is generally contained in the internal air forcing the use of respirators that restrict mobility and impair vision. The current technique of “ventilating” the shelters with a floor fan in the doorway is cumbersome, ineffective and poses a safety hazard.

2.3 General Ambient Air Quality

During the exterior sanding and grinding operations, the residual dust not collected by the vacuum system is introduced into the ambient air and general surroundings. In addition to being a general personnel irritant and housecleaning issue, it is possible that the ambient air may contain undesirable levels of hazardous elements.

3.0 GENERAL RECOMMENDATIONS

The issues are addressed in two categories:

- Dust Collection.
- Air Filtration.

3.1 Dust Collection

By collecting dust at the source as it is produced, much of the problem is solved. It is recommended that the current program to equip all sanders and grinders used in the ECCR with vacuum dust collection provisions be fully implemented.

Currently, vacuum collection sanders do not appear to be used on a regular basis in the dust booths. Use of these tools in the dust booths will provide the following benefits:

- Greatly reduce the amount of dust that is available to be pulled into the booth's inadequate filter system.
- Reduce the amount of residual dust returned to the ambient.
- Reduce the amount of dust that accumulates on the booth floor.
- Possibly remove the requirement for respirator use when sanding.
- Provide the opportunity to use more efficient filters in the booth to upgrade its effectiveness.

The current dust booth filter replacement schedule and policy should be evaluated and a regular regimen established to eliminate the possibility of operation with overloaded filters.

Vacuum collection tools should be used at all times in the other areas as well. It may be necessary to make a variety of additional sizes and styles available to accomplish all the required tasks.

Dust cleanup from the floor inside shelters, the general area floor and other surfaces should be via vacuums connected to the dust collection system or by

stand-alone vacuums with high efficiency filters. This will eliminate the stirring up of dust caused by sweeping or blowing with compressed air.

The existing vacuum dust collection system does not extend into the smaller work bay North of the main work area. Although it appears that currently there is less sanding performed in that area on a regular basis, the same basic dust collection issues apply.

3.2 Air Filtration

Even with vacuum tools, the air inside the shelters contains a significant amount of residual dust often requiring personnel to use respirators. Much of this airborne residual dust moves outside the shelter into the general ambient air during the sanding operation and cleaning process.

It is recommended that portable ventilators equipped with air filtration be used to pull the air containing the residual dust from the shelter when sanding. Use of these devices will provide the following benefits:

- Provide a continuous flow of clean ambient air into the shelter.
- Remove the residual airborne dust from inside the shelter.
- Possibly eliminate the need for respirator use.
- Clean the shelter air with high efficiency filters before returning it to the ambient.
- Eliminate the need for ineffective floor mounted fans that block the doorways of the shelter.

The ventilators are easily rolled into position and connected to a shelter specific adapter by a flexible hose and quick connect clamp. They are operated by standard 115-volt wall outlet power and have a gage indicating when to replace the high capacity disposable filters. The discharge air is filtered by a HEPA filter to meet OSHA requirements for returning air back into the workplace.

Figure #1 is a photo of a representative unit that was tested successfully in the actual application at LEAD on two different sized shelters. See Attachment “A” for a purchase description of the Portable Ventilator with Air Filtration.

Figure #1
Typical Portable Ventilator with Air Filtration

In addition, due to the high volume of exterior shelter sanding creating residual dust, it is recommended that freestanding ambient air cleaners be used throughout the ECCR. These units create a hemi-spherical airflow pattern inside the workspace pulling dirty air down away from the workers and into the floor level intakes. The air is discharged at the highest level possible to blow over the tops of large trailers while not interfering with overhead crane operations.

For the main ECCR bay, six individual units located at staggered intervals along the walls are required. They are sized to filter the ambient air a minimum of 10 times per hour to remove the residual airborne dust. The discharge air is filtered

by HEPA filters to meet OSHA requirements for returning air back into the workplace. Use of these devices will provide the following benefits:

- Remove the residual airborne dust from the ambient and provide a continuous flow of cleaned air inside the ECCR area.
- Create a down draft at the sanding point, pulling the residual dust away from the worker.
- Possibly eliminate the need for respirator use.
- Reduce air stratification in the high bay area. (Usually results in less than a 10 °F difference between floor and ceiling temperatures.)
- Semi-portable installation to permit easy relocation and reconfiguration as the mission of the ECCR changes.

Figure #2 is a photo of a representative unit. See Attachment “B” for a purchase description of the Ambient Air Cleaner.

Figure #2
Typical Ambient Air Cleaner

4.0 INSTALLATION AND OPERATION REQUIREMENTS

4.1 Portable Ventilator with Air Filtration

This unit is completely portable, equipped with wheels and requires only the following connections:

- Plug into standard wall outlet 115-volt power.
- Connect the flexible hose to the shelter adapter via a quick connect locking clamp.

Each unique shelter opening will require a simple reusable sheet-metal adapter that can be attached for the duration of the overhaul operation. As the adapters are shelter opening specific, they must be provided by LEAD.

Six loose mating flanges for the flexible hose end of the adapter will be provided with each individual ventilator.

For shelters with no suitable opening for adapter mounting, an accessory hose extension and intake box can be attached to the flexible duct, placed through the shelter door and located on the floor in the rear of the shelter.

The time between filter changes will be determined by the effectiveness of the vacuum sanders and the time of operation. A magnehelic gage located on the ventilator will be used to determine when filters are to be replaced.

4.2 Ambient Air Cleaner

Each unit is freestanding, capable of being positioned by a forklift and needs only to be connected to 208/203 volt, 3 phase 60 Hz power. (Wired through conduit supplied by LEAD.)

It is designed to be located anywhere air cleaning is desired and may be located directly against a wall if desired. Because it draws and discharges air on three sides, it is best positioned along the area perimeter.

For use in the main ECCR bay it is recommended that six units be installed at approximate locations as shown in Figure #3.

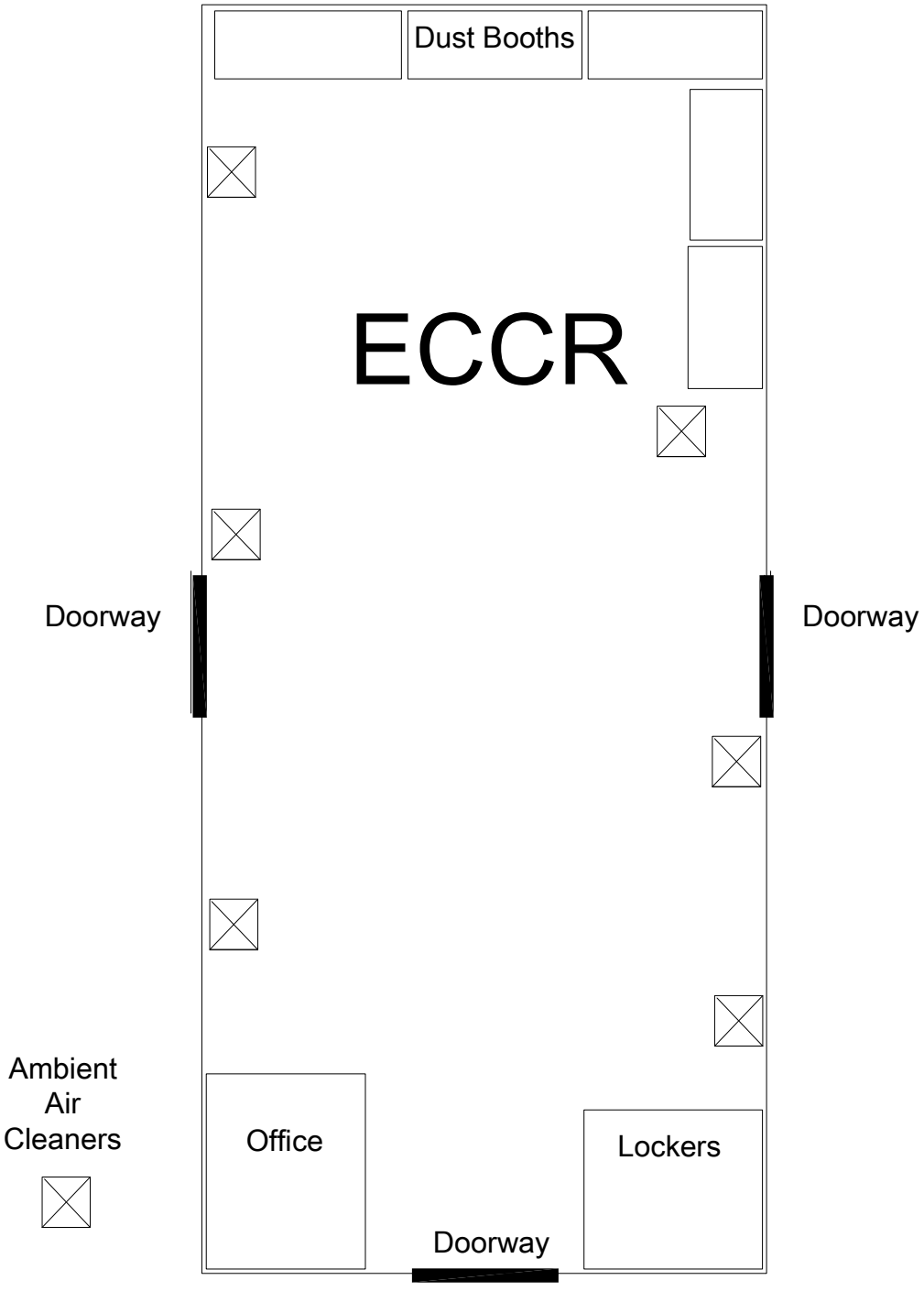

Figure #3
Suggested Ambient Air Cleaner Placement

Additional curtains will be required along the open areas on the North side of the bay. These curtains will prevent airborne dust from leaving the area and insure that the ECCR air is cycled a full 10 times per hour.

The entrance areas should be partitioned using heavy split plastic curtains similar to those in building 350's paint shop to permit easy thru traffic and still contain the air.

5.0 EVALUATION AND SELECTION METHODOLOGY

The evaluation and recommended selection steps consisted of interviews with key personnel, technical analysis of described issues, benchmarking of similar situations in industry with on-site visits, actual tests at LEAD, reviews of commercially available equipment and economic comparisons.

5.1 Interviews

Interviews were conducted with Production Engineering Support, ECCR supervision and operating personnel, Industrial Hygiene, Safety, and HMMWV body shop supervision. The operational requirements identified were:

- Remove airborne dust and contaminants both inside shelters and in the general ambient.
- Meet OSHA specifications for air recirculation in enclosed areas. (HEPA filter on air discharge)
- Eliminate or minimize the need for respirator use.
- Very easy to use.
- Small, occupying a minimum of valuable workspace.
- Easy to maintain.
- Adaptable to the wide variety of shelters and items handled in the ECCR area.
- Able to be reconfigured as the mission of the ECCR changes.
- Reasonable acquisition cost.
- Air must be recycled within the building.

- Installed equipment must not interfere with the overhead crane operation.

5.2 Technical Analysis

Analysis of the operational requirements identified during the interviews and information collected during on-site observations indicated that the following issues needed to be addressed:

- More effective dust collection at the point of generation.
- Ventilation and cleaning of residual airborne dust inside shelters
- Cleaning the ambient air of residual dust in the entire ECCR.

The utilization of the recently installed dust collection system to its fullest capability will remove the bulk of the dust at the point it is generated. This may require the purchase of additional tools and additional operator training.

Because the existing dust collection system, even when fully utilized, cannot capture all the dust generated, equipment for cleaning the ambient air of residual dust was the focus of this effort.

5.3 Types of Commercial Equipment

There are two types of commercially available equipment to remove dust from air using current technologies:

- ***Dust collector.*** This type is essentially a high powered vacuum cleaner designed to move a large amount of material from the point of generation to a self cleaning filtration system with a minimum amount of air at high velocity. The fan and filters may be mounted locally and the clean air returned to the general ambient or directed back at the work area creating a “loop” aiding in dust collection. Alternatively, the fan and filters may be mounted remotely with multiple collection points connected to a common intake plenum having the clean air discharged into the general ambient.

A remote mounted type dust collection system is installed in the ECCR and is currently being phased into operation to collect dust at the point of generation.

This type of equipment is specifically designed to handle a high dust concentration and thus must be equipped with large filters to effectively clean the air. Optimally the system is equipped with self-cleaning features that minimize overall size and eliminate the need for frequent maintenance.

Different configurations of the locally mounted type system may also be used to clean ambient air for lower concentrations of airborne dust.

- ***Air Cleaner.*** This type is essentially a large enclosed fan with replaceable filters designed to remove low concentrations of airborne dust from very large volumes of air. The air is pulled into the fan enclosure at low velocity through openings near the floor, passes through a series of filters and is discharged at the top with a high velocity to widely disperse it creating a large hemi-spherical flow pattern.

  This equipment is designed to use replaceable filters because it is not expected to remove the high level of material as the "dust collector" type mentioned above. Typically high capacity, depth-loading, pocket type filters are used to minimize maintenance intervals.

5.4 Benchmarking

Several industrial manufacturing sites were identified which had similar air quality issues as LEAD. The first was the preparation area of a highway vehicle overhaul shop where sanding and grinding prior to painting was performed. Another facility was a job shop metal fabrication facility that had unacceptable levels of airborne dust and fumes from welding, sanding and grinding. The third was a heavy equipment metal fabricating facility with high bays similar to the ECCR. These sites are currently using "air cleaner" type equipment as identified above.

The users at the last two installations reported dramatic improvements in air quality with ambient “air cleaners” sized to provide 10 complete air changes per hour. The facility with the high sanding dust load had seen some improvement with a small wall mounted “air cleaner” that only provided 2 to 3 air changes per hour and was in the process of upgrading to equipment that will provide a minimum of 10 changes per hour.

The benefits reported by the users were:

- Elimination of visible “haze” in the factory air.
- Increased general “cleanliness” of the factory environment, eliminating much of the preventative and corrective maintenance for cleaning equipment and dirty mechanisms as well as increasing the time between protective filter replacements on other critical items.
- Ability to use non-enclosed, standard computers and keyboards on the factory floor due to dust reduction.
- Prompted workers’ compliments and thanks due to reduction of respiratory health issues.
- Significantly reduced winter heating bills by eliminating heat build-up in the high bays. The heat collected at the top of the bays produced by high-powered lighting and internally generated heat was returned to floor level by the circulating action of the fans. A less than 10 °F difference was documented.

5.5 Tests at LEAD

Eliminating residual airborne dust when working inside the shelter presented a unique problem. Even when using vacuum tools, the residual dust is severe enough to impair vision and require use of a respirator when sanding. In attempts to move air through or cool the shelters, personnel often placed large pedestal mounted fans in the doorways. This created turbulence inside the shelter but was not effective. The fan is cumbersome, creates a potential safety hazard blocking the exit and any air that does exit, contains dust that contributes to the ambient air problem.

An “air cleaner” type portable air ventilator with internal filters similar to the type specified in Attachment “A” was tested on two different shelters. The equipment was positioned out of the work access area with the flexible duct connected to an opening opposite the shelter door. This created a laminar airflow through the shelter bringing clean air into the enclosed area through the door and pulling dusty air out through the flexible duct. The air was filtered and returned to the ambient at the base of the ventilator.

Even when sanding without a vacuum tool, none of the dust was forced into the ambient and it was either captured by the ventilator or fell to the enclosure floor. However, the airborne concentration was too high to work without a respirator.

It was determined that a 100 linear feet per minute is required at the doorway to achieve good airborne residual dust removal when using the vacuum sanding tools.

5.6 Economic Comparison

The acquisition cost of “air cleaning” equipment is approximately $1200 per 1000 CFM. The “dust collection” equipment acquisition cost is significantly higher at $3600 per 1000 CFM due to the internal complexity to collect, automatically clean and remove the material.

Other cost factors are:

- ***Size.*** “Dust collectors” are approximately 2.5 to 3.0 times as large as “air cleaners” occupying more valuable floor space and making installation less flexible.
- ***Power Consumption.*** “Dust collectors” require greater horsepower per CFM caused by higher internal pressure drops across the self-clean filters.
- ***Additional Hook-up’s.*** “Dust collectors” require compressed air for self-cleaning operations.

5.7 Equipment Selection

5.7.1 Shelter Interior Air

An “air cleaner” type portable ventilator is recommended for the shelter interior application. It has a low acquisition cost of approximately $3000, only occupies 4.7 ft^2 of floor space, is easily moved on wheels, plugs into 115-volt power outlets and requires no external compressed air connections.

The main collection filter is an 18-inch deep, cube filter with very high dust capacity. The unit also includes a 4^{th} filtration stage due to the anticipated higher concentration of airborne dust inside the shelter than outside ambient air. This will extend filter life and increase the time between changes. Filter life will depend upon the amount of usage and dust concentration of the interior air. The unit is specified to have a magnehelic gage sensing the pressure drop across all filters to aid in replacement determination.

A cam action, quick connect, locking clamp is specified to connect the flexible duct to the shelter adapter so that the ventilator may be easily removed when shelters are moved during the overhaul process.

On large shelters with more than one door or many side openings that are not covered, it may be necessary to use two ventilators in parallel to obtain the required 100 linear feet per minute airflow.

As many individual ventilators should be purchased as necessary to insure that each shelter in the ECCR undergoing internal sanding operations is properly ventilated.

The Purchase Description for the Portable Ventilator with Air Filtration is included as Attachment “A”.

5.7.2 Ambient Air Cleaner

An "air cleaner" type air filtration unit is recommended to remove the residual airborne dust from the ambient air of the entire ECCR. This equipment was selected over "dust collector" type units primarily because it is specifically designed for this type of application, has significantly lower acquisition cost, approximately $10,000 per unit vs. $29,000 per unit and requires only about 35% of the floor space for the same CFM capacity.

The individual units are small enough to fit in staggered locations along the walls of the ECCR and can be easily moved by forklift to other areas if desired. The only connection is 208/230 volt, 3-phase power available from most any lighting distribution panel.

Six units are required to provide 10 complete air changes per hour for the entire 260,000 ft^3 of the main high bay. The air in the area to be cleaned must be isolated from the remainder of the building by walls of plastic sheeting similar to the barriers which already exist along part of the perimeter.

Similarly, other areas may be cleaned by enclosing the sides and installing the required number of Ambient Air Cleaners.

Based upon the experience from other users in similar applications, it is anticipated that the pre-filter and secondary stage filters will only need to be replaced approximately once per quarter, with the HEPA final filter lasting at least twice as long. Annual filter cost is anticipated to be approximately $3600. (The initial set(s) of filters may need to be replaced more frequently until the general environment in the ECCR has been cleaned as the constant air movement picks up dust that has collected on all surfaces.)

The Purchase Description for the Ambient Air Cleaner is included as Attachment "B".

5.8 Total Project Cost

The total installed cost is estimated at $90,900 as follows:

Item	Quantity	Price Each	Total Cost
Ambient Air Cleaners	6	$10,000	$60,000
Electrical Connections	6	$250	$1,500
Portable Ventilators (Estimated qty)	6	$3,000	$18,000
Adapters	24	$100	$2,400
Plastic wall sheeting & installation	AR		$3,000
Strip "drive thru" doors	3	$2,000	$6,000
		Total	**$90,900**

6.0 OTHER POTENTIAL OPTIONS

In an effort to be proactive on the dust issues without being disruptive to the ECCR operations and utilize the equipment currently in place, the scope of this project was limited to additional equipment that could easily complete the collection and removal of airborne residual dust.

There are other options that are available if reconfiguration or relocation of the ECCR area is desired. These options include:

- Replacement of the existing vintage dust booths with current technology high efficiency, recirculating air booths. The main benefits are.

- Higher air velocity to remove dust at the source without special tools.

- Directs clean air down onto the work area to “wash” the workers vision and breathing zones.

- Eliminates need for operator respirators.

- Eliminates residual dust in the ambient air by returning clean, HEPA filtered air to the workspace.

- May be modularized to increase or decrease booth sizes, giving flexibility as the ECCR mission changes.

- May be free standing with self cleaning filters or connected to a central dust collection system.

- Installation of an “air wall” type system in a large enclosed area. This essentially creates a large, high-powered dust booth simultaneously performing both the functions of vacuum collection tools and ambient air cleaners in one unit. The main benefits include:

    - Ability to accommodate work items of any size.

    - Higher air velocity to remove dust at the source without special tools.

    - Directs clean air down onto the work area to “wash’ the workers vision and breathing zones.

    - Eliminates need for operator respirators.

    - Eliminates residual dust in the ambient air by returning clean, HEPA filtered air to the workspace.

    - May be free standing with self cleaning filters or connected to a central dust collection system.

While these options may provide a better method of removing the dust from the source and simultaneously cleaning the ambient air, they are more capital intensive and suited for new or revamped installations. There are many configurations of equipment available to implement these concepts, thus investigation and specification would be best suited to accompany a new project.